

ing to this definition, the answer is "Zero," but ordinary people would calculate the result in millions of tons, from the data of the mean radius and the mean density.

Take again a question of a similar nature: "Prove that 288 pounds at the pole weigh the same as 289 pounds at the equator." To realise this question we must imagine a balance constructed of which the arm is curved into a quadrant of the earth, reaching along a meridian from the pole to the equator, and supported by a fulcrum in latitude 45° ; then 288 pounds at the pole will equilibrate 289 pounds at the other end of the balance at the equator. Without requiring a balance with so long an arm, we can have 289 pounds at the bottom of the shaft of a mine weighing the same as 288 pounds at the surface, provided the shaft is of sufficient depth.

Some years ago, being troubled myself with this confusion of language, I wrote to Prof. Maxwell to ask him for a good illustrative example of the correct and incorrect use of the word "weight," and received the following characteristic reply on a postcard:—"Compare St. John xix. 39, *ὅσει λίτρας ἑκατόν*, with the A.V. (authorised version), and keep to the original Greek." The translation in the authorised version is "about a hundred pounds weight."

Here we see that Maxwell recognised the ambiguous nature of the word "weight," and advised its omission wherever possible; but the exigencies of language compel us to use it; and in fact we shall generally find writers, even after the above incorrect definition of weight, proceed subsequently to use the word in its ordinary meaning of daily life.

I wish to repeat that writers on dynamics only create confusion in appropriating the word "weight" to the sense of the force of attraction of the earth on a body, as we never speak of "a force weighing so many pounds"; and I wish to support the language in ordinary use by engineers and practical men as perfectly correct in using the words "pound" or "ton" side by side in two senses, first as meaning the weight (or mass) of a body, and secondly as meaning the force with which the body is attracted by the earth; one being sometimes distinguished as a pound weight, and the other as a pound force.

If we use Prof. James Thomson's admirable word "poundal" for the British absolute unit of force, this slight confusion of terms will disappear, although engineers will still continue to think in gravitation units of force, as gravity is the one universal force from which there is no escape; and I fear it will be impossible ever to persuade them to think in C.G.S. units like the centimetre, gramme, dyne, erg, &c., which, though admirably adapted for the minute measurements of experiments in physics, are unsuitable for large magnitudes.

In conclusion, let the equation $W = Mg$ be dismissed from the text-books, as leading to statements such as "The mass of a body weighing W pounds is $\frac{W}{g}$," the true equivalent equation being

$W = M$, and therefore unnecessary; and with it let the confusing "astronomical unit of mass" disappear, and introduce instead the "constant of gravitation" in our equations. Let us also recognise that the primary idea of "weight" is the same as "mass," and form our dynamical definitions on the usages of ordinary language.

A. G. GREENHILL

Woolwich, February 28

Mr. Herbert Spencer's Definition of Life

I HAVE read with much interest the report in NATURE of Prof. Judd's address to the Geological Society, in which he attempts to show that Mr. Herbert Spencer's definition of life is not restricted to those cases only which display the ordinarily acknowledged characteristics of vitality; a certain correspondence between internal and external changes being displayed by minerals.

I write to draw attention to what I think tends to show that the mass of evidence brought forward really tells in favour of the definition; bearing in mind that the hypothesis of evolution "implies insensible modifications and gradual transitions, which render definition difficult—which make it impossible to separate absolutely the phases of organisation from one another" ("Principles of Biology," vol. ii. p. 10), and that consequently there can be no "absolute" commencement of life.

The fact, treated by Mr. Spencer when seeking a definition of life, that there is a correspondence between life and its cir-

cumstances gives the clue showing us that the "vitality of minerals" is a misnomer; a fallacy he himself exposes when he treats of the internal actions—the feathery crystallisation—displayed by the misnamed storm glass in correspondence with external changes. Using his own words, we see that:—

"Subtle as is the dependence of each internal upon each external change, the connection between them does not, in the abstract, differ from the connection between the motion of a straw and the motion of the wind that disturbs it. In either case a change produces a change, and there it ends. The alteration wrought by some environing agency on an inanimate object, does not tend to induce in it a secondary alteration, that anticipates some secondary alteration in the environment. But in every living body [in a living body, mark!] there is a tendency towards secondary alterations of this nature; and it is in their production that the correspondence consists. The difference may be best expressed by symbols. Let A be a change in the environment; and B some resulting change in an inorganic mass. Then A having produced B, the action ceases. Though the change A in the environment, is followed by some consequent change a in it; no parallel sequence in the inorganic mass simultaneously generates in it some change b that has reference to the change a. But if we take a living body of the requisite organisation, and let the change A impress on it some change C; then, while in the environment A is occasionally a, in the living body C will be occasioning c: of which a and c will show a certain concord in time, place, or intensity. . . ." (vol. i. p. 78).

"That the word *correspondence* will not include, without straining, the various relations to be expressed by it," is best met by the reply "that we have no word sufficiently general to comprehend all forms of this relation between the organism and its medium, and yet sufficiently specific to convey an adequate idea of the relation; . . . The fact to be expressed in all cases, is, that certain changes, continuous or discontinuous, in the organism, are connected after such a manner that, in their amounts, or variations, or periods of occurrence, or modes of succession, they have a reference to external actions, constant or serial, actual or potential—a reference such that a definite relation among any members of the one group, implies a definite relation among certain members of the other group; and the word *correspondence* appears the best fitted to express this fact." (vol. i. p. 79).

In deer-stalking we see a realisation of these symbols. In the deer the primary internal change—the perception of odour, or, as I believe it is called, "winding"—is followed by that secondary internal change which induces a desire to increase the distance between the living organism and the inferred source of danger, a change differing not only in degree, but in kind, differing *toto caelo* from any of those actions which take place in minerals and crystals.

That the address contains many valuable facts furthering not only Mr. Spencer's view of life, but also his views of evolution, becomes apparent when we consider how it carries out and develops these ideas to an extent which would have been impossible at the time when the "Principles of Biology" were first published, now twenty years since. I say "furthering," for I wish now to touch upon a very important point, which I cannot but think has been much enlarged and amplified by Prof. Judd. It is to the much more expanded meaning which can now be attached to the fact that the degree of life varies as the degree of correspondence between internal and external relations.

For the correspondence displayed by a crystal or mineral is shown to be of a very much lower degree than that displayed by the simplest plant or animal. These latter present correspondences of greater complexity, greater rapidity, and greater length in the series of them than the former, which, during its long "millions of years," can respond only to the two or three forms of molar and molecular forces alluded to. The changes in the mineral simply respond to changes in the environment; whereas in an organism it is a relation between changes in it which responds to a relation between changes in the environment.

Churchfield, Edgbaston

F. HOWARD COLLINS

An Equatorial Zone of almost Perpetual Electrical Discharge

THE recent reference in your columns to Edlung's theory of the aurora borealis, recalls a very curious observation that I

have made in my travels of a zone of almost perpetual electrical discharge in the belt of the "doldrums" all round the world.

Anywhere in that belt, a more or less intermittent display of sheet lightning commences the moment the twilight of sunset has sufficiently faded away, and continues with varying intensity till the light of morning prevents further observation.

The localisation of this belt of lightning is very obvious as we run a section across the equator on board ship. There is very little electrical discharge in the high-pressure belt of anticyclones which encircle the earth approximately under the lines of the tropics; but as we approach the low-pressure band of the "doldrums," where the two trade-winds, or the two monsoons meet, then the display of lightning is of nightly occurrence, even if there are no actual thunderstorms.

This electric discharge has a diurnal period like every other meteorological element; for night after night, as I have slept on deck in Malaysia during the change of the monsoons, I have noticed a very marked diminution of the lightning after 1 or 2 a.m. If a total eclipse of the sun could last for twelve hours, I have no doubt that we should see more or less lightning all the time, with a regular set of diurnal variations.

Edlung and others have noticed the gradual decrease in the frequency of thunderstorms as we recede from the equator; but I wish to show now, not only that the discharge is of nightly occurrence, but that the locality of maximum effect is not so much on the equator as in the "doldrums." The sheet lightning may be the reflection of distant thunderstorms, or it may be the silent discharge of electricity. Meteorologists are much divided as to the possibility of the latter; but it is certain that the amount of sheet lightning is out of all proportion to the frequency of actual thunderstorms.

Is it not possible that we may find in this perpetual lightning, some clue to the origin of earth-currents everywhere? and in the diurnal variation in the discharge, some probable reason for the hourly variation of the aurora, and of some magnetic elements? No doubt it is at present difficult to connect the electricity of lightning with the electro-magnetic effects of terrestrial magnetism or the aurora; and though Edlung's theory is defective in this respect, I cannot help thinking that he is right in collating thunderstorms on the equator with the glow discharge of electricity on the Arctic circle; and it is in the hope that the discovery of the constancy of electrical discharge in the "doldrums" may perhaps assist in the evolution of a true theory of the aurora, that I have penned this short notice.

RALPH ABERCROMBY

21 Chapel Street, London, March 15

Scorpion Virus

PROF. BOURNE'S experiments, related in the Proceedings of the Royal Society of January 6, 1887, seem to establish the fact that although the scorpion may be provoked to strike and wound itself or another scorpion, it is incapable, in either case, of causing any toxic action, however active the virus may prove in respect of other creatures. That it is, in short, with the scorpion as it is with the cobra or viper: they poison other creatures, but not themselves or each other.

Some years ago an exhaustive series of experiments brought me to the conclusion that a cobra is not poisoned by cobra virus, whether inoculated by its own fangs, by those of another cobra, or by a hypodermic syringe. The same in the case of daboia and other viperine snakes.

It seemed, however, that the bungarus, a less deadly snake than the cobra, occasionally is affected, though slowly, by the cobra virus, but that it escapes more frequently than it suffers; and when it does suffer the effect of the poison is greatly diminished. On the other hand, non-venomous snakes, lizards, frogs, fish, mollusca, and other low forms of life, all rapidly succumb to snake poison.

The details of these experiments are to be found in the "Thanatophidia of India," published in 1872, and in referring to them Prof. Bourne remarks: "They show conclusively that the cobra poison will not affect a cobra, and will not even affect the viperine pyas." I would correct the latter part of the quotation so far as to say that the pyas is a colubrine harmless snake, not a viperine snake, and that it rapidly succumbs to the cobra virus.

Prof. Bourne has helped to dispel another of the popular delusions which cling round venomous creatures.

March 14

J. FAYRER

THE RELATION OF TABASHEER TO MINERAL SUBSTANCES

MR. THISELTON DYER has rendered a great service, not only to botanists, but also to physicists and mineralogists, by recalling attention to the very interesting substance known as "tabasheer" (NATURE, vol. xxxv. p. 396). As he truly states, very little fresh information has been published on the subject during recent years, a circumstance for which I can only account by the fact that botanists may justly feel some doubt as to whether it belongs to the vegetable kingdom, while mineralogists seem to have equal ground for hesitation in accepting it as a member of the mineral kingdom.

It is very interesting to hear that so able a physiologist as Prof. Cohn intends to investigate the conditions under which living plants separate this substance from their tissues. That unicellular Algæ, like the Diatomaceæ, living in a medium which may contain only one part in 10,000 by weight of dissolved silica, or even less than that amount, should be able to separate this substance to form their exquisitely ornamented frustules is one of the most striking facts in natural history, whether we regard it in its physiological or its chemical aspects.

Sir David Brewster long ago pointed out the remarkable physical characters presented by the curious product of the vegetable world known as "tabasheer," though so far as I can find out it has not in recent years received that attention from physicists which the experiments and observations of the great Scotch philosopher show it to be worthy of.

Tabasheer seems to stand in the same relation to the mineral kingdom as do ambers and pearls. It is in fact an *opal* formed under somewhat remarkable and anomalous conditions which we are able to study; and in this aspect I have for some time past been devoting a considerable amount of attention to the minute structure of the substance by making thin sections and examining them under the microscope. It may be as well, perhaps, to give a short sketch of the information upon the subject which I have up to the present time been able to obtain, and in this way to call attention to points upon which further research seems to be necessary.

From time immemorial tabasheer has enjoyed a very high reputation in Eastern countries as a drug. Its supposed medicinal virtues, like those of the fossil teeth of China and the belemnites ("thunderbolts") of this country, seem to have been suggested by the peculiarity of its mode of occurrence. A knowledge of the substance was introduced into Western Europe by the Arabian physicians, and the name by which the substance is generally known is said to be of Arabic origin. Much of the material which under the name of "tabasheer" finds its way to Syria and Turkey is said, however, to be fictitious or adulterated.

In 1788 Dr. Patrick Russell, F.R.S., then resident at Vizagapatam, wrote a letter to Sir Joseph Banks in which he gave an account of all the facts which he had been able to collect with respect to this curious substance and its mode of occurrence, and his interesting letter was published in the Philosophical Transactions for 1790 (vol. lxxx. p. 273).

Tabasheer is said to be sometimes found among the ashes of bamboos that have been set on fire (by mutual friction?). Ordinarily, however, it is sought for by splitting open those bamboo stems which give a rattling sound when shaken. Such rattling sounds do not, however, afford infallible criteria as to the presence or absence of tabasheer in a bamboo, for where the quantity is small it is often found to be closely adherent to the bottom and sides of the cavity. Tabasheer is by no means found in all stems or in all joints of the same stem of the bamboos. Whether certain species produce it in greater abundance than others, and what is the influence of soil, situation,